IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.	:	**10/774,471**	Confirmation No. 9120
Applicant	:	A. YAMAMOTO	
Filed	:	February 10, 2004	
Title	:	HIGH SPEED DATA TRANSFER BETWEEN MAINFRAME STORAGE SYSTEMS	
TC/AU:	2116		
Examiner	:	A.I. Elamin	
Docket No.	:	274.43020CX2	
Customer No.:		24956	

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

DECLARATION UNDER 37 CFR 1.131

I, Akira Yamamoto, declare the following:

(1) That I am the sole inventor of the invention described and disclosed in the above patent application.

(2) That the invention was conceived and actually reduced to practice prior to November 29, 2000.

(3) That I disclosed the invention in a HAL Invention Disclosure (Exhibit A) prior to November 29, 2000, and that the invention was already reduced to practice by me in the United States at least as early as the time of the HAL Invention Disclosure, as demonstrated by the content of the HAL Invention Disclosure. In particular, the HAL Invention Disclosure includes the disclosure of a remote storage system connected to a local storage system, wherein the remote storage system stores a copy of data that the local storage system stores. (See, e.g., FIG. 1 and page 5, first paragraph of Exhibit A.) Also disclosed is receiving, from the local storage system, fixed-block formatted data converted from mainframe formatted data, the mainframe formatted data being provided to the local storage system by a host computer connected to the local storage system. (See, e.g., page 9, second paragraph, of Exhibit A.) Further disclosed is, in response to a mainframe command received from a host computer connected to the remote storage system, converting the fixed-block formatted data to mainframe formatted data. (See, e.g., page 9, second paragraph, of Exhibit A.) Also disclosed is storing the fixed block data in a

cache memory, as disclosed, e.g., by element 113 of FIG. 1. Also disclosed is that the mainframe command is a read command, as disclosed, e.g., at page 9, second paragraph. Also disclosed is that the mainframe data is CKD and the fixed block data is SCSI, as disclosed, e.g., at page 5, paragraphs 1 and 2. Further, disclosed is a first interface 119 connected to a host computer for receiving a mainframe command and a second interface 120 connected to a first data storage system for receiving fixed-block formatted data converted from mainframe formatted data. (See, e.g., FIG. 1 and page 5, first paragraph of Exhibit A.) Also disclosed is that mainframe formatted data is provided to the first storage system by a first host computer connected to the first storage system, as disclosed, e.g., at page 5, first paragraph. Also disclosed is that, in response to a mainframe command, mainframe formatted data converted from the fixed-block formatted data received from the first data storage system is sent to the host computer through the first interface, as disclosed, e.g., at FIG. 1 and page 9, second paragraph. It is understood that the foregoing citations are exemplary, and that the Examiner must consider all of the disclosure of Exhibit A in its entirety.

(4) That, as further proof of actual reduction to practice, the HAL Invention Disclosure was read, understood, and signed by two disclosure reviewers (witnesses) prior to November 29, 2000.

(5) That a true copy of the original HAL Invention Disclosure that was signed by me and the two witnesses prior to November 29, 2000, is attached to this Declaration as Exhibit A with the dates of execution redacted.

I, Akira Yamamoto, further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Akira Yamamoto
Akira YAMAMOTO

6/ 6 / 2006
Date

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DECLARATION UNDER 37 CFR 1.131
EXHIBIT A

OIPE IAP45
JUN 0 6 2006
PATENT & TRADEMARK OFFICE

HAL INVENTION DISCLOSURE [redacted]

HAL CONFIDENTIAL (when completed)

Title of the Invention: Remote Copy for Mainframe System
(short and descriptive)

Instructions:
Attach typewritten or computer-printed pages which provide all the information requested for the sections listed below. Identify each section with the heading indicated. Provide all information requested to the best of your knowledge. Each page should be signed and dated by each inventor and two witnesses who have read and understood the disclosure (a sample page is provided, and may be copied as many times as necessary to complete the disclosure). Laboratory managers should rate the invention in accordance with the rating schedule in section IV. C1 of R&D policy 002. Consult your local Patent Administrator or the Senior Patent Administrator, if necessary, for further details on completion of an Invention Disclosure. See also R&D policy 002.

Sections:
Problem Solved by the Invention: Briefly describe the problem solved by this invention or the requirement which led to the invention. Discuss the need for the invention, and identify the problems of the closest prior technology which the invention solves.
Summary of the Invention: Summarize the invention in general terms. State the novel feature(s) of the invention which solve(s) the problem(s) identified in Section I. Set forth the basic idea of the invention.
Prior Art: Discuss any prior art or previous approach to the solution of the problem known to the inventor, including disadvantages and difficulties in past practice. Identify all pertinent literature (patents or published articles) and other public disclosures of which you are aware.
Detailed Description: Describe the specifics of the invention. Use drawings, flow charts, block diagrams, schematics, tables, formulas, test results, etc. (free from HAL codes and jargon) as appropriate. Include a broad description, preferred embodiments and specific examples. List the advantage(s) over the prior technology which the invention provides.
Use of the Invention: Indicate one or more uses for the invention. Note all plans, if any, for exploiting the invention commercially.
Records/Reports: Notebook No./Page No.: ____/____; Date: ______, 19__; Authors: ______.
______ Other (e.g., technical reports, memos, etc.): ______
______; Date: ______; Authors: ______.

Invention Conception date: ______ Invention Reduction to Practice date (if any): ______

Date of anticipated publication (if any): ______

Inventor(s):

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Read and understood by: (1) [signature] (signature) [redacted]
(Two disclosure reviewers)
(2) Kenji Yamagami (signature) [redacted] (date)

Location of Laboratory: ______

Sponsors of Invention Disclosure: ______
(List major sponsor first)

Laboratory Manager	File Application Now? Yes/No	General Manager R&D	File Application Now? Yes/No	Sponsor	Support Application Yes/No	Senior Patent Administrator	Disclosure Number
HAL [redacted]		HAL [redacted]				HAL [redacted] CUNNINGHAM	159

Based on
SNTL Agreement

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I. PROBLEM SOLVED BY THE INVNETION

Remote dual copy function is the one which provides the real time copy in a remote site aiming at realizing the disaster recovery. So this function is typically realized based on a mainframe system because a computer system for disaster recovery needs very high availability and a mainframe system is much more superior to other computer systems in availability. In conventional remote dual copy for mainframe system, a mainframe I/O protocol called CKD (Count-Key-Data) protocol is used as a data transfer protocol between a local disk system and a remote disk system. In CKD protocol the length of the block (= record) is variable. And the data transfer speed of a mainframe I/O interface is 17 MB/S.

On the other hand, a SCSI protocol used in an open system is a protocol based a fixed length of block. Generally speaking, the software (control) overhead of the protocol based on a fixed length of block is smaller than the software (control) overhead of the protocol based on a variable length of block. And the data transfer speed of a open system I/O interface is 100MB/S. Therefore a data transfer infrastructure based on a mainframe I/O protocol is less efficient than one based a open system I/O protocol.

The problem to be solved by this invention is to provide a more efficient data transfer infrastructure between a local disk system and a remote disk system in a mainframe remote copy system.

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II. SUMMARY OF THE INVNETION

This invention aims at providing a more efficient data transfer infrastructure between a local disk system and a remote disk system in a mainframe remote copy system.

Basically this invention utilizes a fixed length of block architecture such as a SCSI interface as a data transfer infrastructure between a local disk system and a remote disk system in a mainframe remote copy system. However, a mainframe's block (=record) is a variable length. So a local storage system sends write data after variable/fixed conversion.

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III. PRIOR ART

Remote copy function for a mainframe system has been already commercialized. But, in the conventional remote copy function for a mainframe system, a mainframe I/O protocol called CKD (Count-Key-Data) protocol is used as a data transfer protocol between a local disk system and a remote disk system.

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Naoko Iwami	[redacted]	Kenji Yamagami	[redacted]

iv. DETAILED DESCRIPTION

Fig.1 shows the total configuration the first embodiment. A local mainframe system 100 consists of a local mainframe HOST system 102 and a local disk system 104. A remote mainframe system 101 consists of a remote mainframe HOST system 103 and a remote disk system 105. A local disk system 104 is connected through a CKD(Count Key Data) interface 119 with a local mainframe HOST system 102 A remote disk system 105 is also connected through a CKD interface 119 with a remote mainframe HOST system 103. A data transfer infrastructure based on fixed block interface 121 is the one between a local disk system104 and a remote disk system 105. Each of a local disk system104 and a remote disk system 105 is connected through 120 a fixed block interface 120 such as a SCSI interface with a data transfer infrastructure based on fixed block interface 120. A local disk control unit 106 and a remote control disk unit 107 execute the processing for a read/write request.

A read/write unit in a mainframe system is called a record. The length of a record in a mainframe system is variable. On the other hand, a read/write unit in an open system is called a block. In an open system a fixed block interface 120 such as a SCSI interface is adopted. Generally speaking, the software (control) overhead of the protocol based on a fixed length of block is smaller than the software (control) overhead of the protocol based on a variable length of block. And the data transfer speed of a fixed block interface 120 such a SCSI interface is faster than the one of a CKD interface 119 adopted in a mainframe system. In this invention, to make a data transfer processing between a local storage system 104 and a remote disk system 105 efficient, the data transfer infrastructure based on a fixed block interface 120 is adopted.

A typical read/write request in a mainframe consists of several commands called a command chain. A typical sequence of command chain is shown below.

Define Extent: Command : species cache utilization mode etc.

Locate Command : specifies a record to be accessed and includes the parameters shown below.

cylinder number and head number : specifies a track to be accessed
sector number : specifies sector to start searching record
record number : specifies record number to be searched(record to be accessed)

Read Command/Write Command : reads or writes a record. In the case of reading or writing more than one records in one command chain, typically, more than one read commands or write commands are chained.

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In a mainframe system, the length (=capacity) of a track is fixed. Originally, a track is circular. Fig.2 shows the track format of a mainframe system. Fixed angle into which a tack is divided is called a sector 205. As the length of a track is fixed, the length of a sector is considered fixed. In the head of a track, a control information called HA 200 (Home Address) is stored. Next, the first record called R0 is stored. A gap 204 which is fixed length, is stored between a HA200 and RO. A record of a mainframe system consists of C(Count field) 201 and D(Data field) 203 or C201 and K(Key field)202 and D203. A gap 204 is also stored between a record and a record. Moreover, a gap 204 is also stored between each field such as C201, K202, and D203. C201 is fixed length and include the control information of the record such as a record number, K202 's length and data D 203's of the record. When the record does not include K, K202's length is 0. K202 includes key information to access the record. In D203, user data or system is stored. Generally, RO does not include K202 and the user data, but system data is stored is stored in D203 of R0. The second record is called R1. The n+1 record is called Rn. In the D 203 of the records except R0, user data is stored. The record number of Rn is not always 'n'. The mainframe system can assign the arbitrary number to the record number of Rn. So, searching the record including the record number specified in Locate Command, the record number in C201 of each record must be checked.

In this invention, a record written through a CKD interface 119 is sent to a remote disk system 105 through a block interface 120 such as a SCSI interface. In a SCSI interface, a typical read/write request consists of one command shown below. (So, the control overhead of a fixed block interface 120 such as a SCSI interface is much less than the one of the CKD interface 119)

Read Command or Write Command: includes block address and block length (read or write from the specified block address by the numbers of blocks specified in block length)

So, before sending, a local disk system 106 must convert variable length of records into fixed length of blocks. As the length of the track is fixed, one track can be replaced into a fixed number of blocks. So when the track number is specified, the head block address corresponding to the track can be obtained easily. As shown in Fig.3, from the head of the track, the area whose length is equal to the block length can be assigned to one block 700. Thus, the address of a block corresponding to each record in the track can be obtained

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In the first embodiment, the management of cache memory is based on a block interface 120. So, a mainframe read/write process 108 which executes a read/write request received from a local mainframe HOST system 102 or a remote mainframe HOST system 103 has a CKD/FBA(Fixed Block Architecture) conversion function 115. Cache memory 113 consists of segments116. In this invention, a segment 116 is area which is the one to store the amount of data equal to the size of one track. That means that the size of a segment 116 is equal to the size of the blocks into which one track is converted.

Fig.4 shows the structure of the remote copy pair information 117 in shared memory 114. A local storage system address 400 and a disk unit address 401 specifies the address of a disk unit 112 in a local disk system 102 whose write data should be sent to a disk unit 112 in a remote disk system 103. A remote storage system 402 and a disk unit address 401 specifies the address of a disk unit 112 which receives write data from a local disk system 103.

Fig.5 shows the structure of the segment control block 118 which exists corresponding to a segment . A disk unit address 500 means the address of a disk unit 112 which is allocated to the corresponding segment. A top address of blocks to this segment 501 means the address of the block which is the top block of the blocks which are allocated to the corresponding segment 116. Each bit of block bit map 502, write block bit map to remote disk 503 and write block bit map to local disk 504 is corresponding to a block. So, the number of bits of block bit map 502, write block bit map to remote disk 503 and write block bit map to local disk 504 is equal to the number of the blocks which is stored into one block. When each bit of block bit map 502 is on, it shows that the corresponding block exits in cache memory 113. When each bit of write block bit map to remote disk 502 is on, it shows that the corresponding block needs to be sent to a remote disk system 105. When each bit of write block bit map to local disk 502 is on , it shows that the corresponding block needs to be written to a disk unit 112 in a local disk system 104.

The processing of a mainframe read/write process 108 in a local disk system 104 for a write request is as follows. The explanation of the processing for a read request is abbreviated. Because this invention relates to a remote copy function which means that a local disk system 104 sends write data to a remote disk system 105.

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Receiving Define Extent Command, a mainframe read/write process 108 recognizes the cache use mode etc. specified by that command. Receiving Locate Command, firstly, a mainframe read/write process 108 searches a segment control block 118 to check whether the corresponding blocks to a specified track in the command is allocated to a segment 116 or not by utilizing a CKD/FBA conversion function 115. When it is allocated, a mainframe read/write process 108 checks whether the corresponding blocks specified by the sector number in the command exists in cache memory 113 by referring to block bit map 502 and by utilizing a CKD/FBA conversion function 115. When the corresponding blocks exist in cache memory 113, a mainframe read/write process 108 finds a record to be written to by using a record number specified in the command. Then a mainframe read/write process 108 receive a Write Command and write data and store write data to the area corresponding to the found record. Next, a mainframe read/write process 108 turn on the bits in write block bit map to remote disk 503 and write block bit map 504 which corresponds to the record to be written to.

When the corresponding blocks to the specified track is not allocated to a segment 116, a mainframe read/write process 108 allocates those blocks to a segment 116 and then request to load those blocks from a disk unit 112 to a disk unit read write process 111. When the corresponding blocks to the specified sector number do not exist in cache memory 113, a mainframe read/write process 108 allocates those blocks to a segment 116 and then request to load those blocks from a disk unit 112 to a disk unit read write process 111. After the loading, a mainframe read/write process 108 starts finding a record to be written to by using a record number specified in the command. The processing hereafter has been described.

The processing of a I-write data send process 109 is as follows. A I-write data send process 109 finds the segment control block 118 which include write bit map to remote disk 502 in which at least one bit is on. Next a I-write data send process 109 searches a remote copy pair information 117 and finds the address of a remote disk system 105 and a disk unit 112 to send write data by using dislk unit address 500 in the found segment control block 118. Then a I-write data send process 109 send the data of the blocks corresponding to the bits which is in write bit map to remote disk 502 and is on, to a remote dislk system 105. After it received the notify of the completion of the processing from a remote disk system 105 a I-write data send process 109 turn off the bits which is in write bit map to remote disk 502 and is on.

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The processing of a r-write data receive process 110 is as follows. A r-write data receive process 110 plays a role to receive write data for the specified blocks in the specified disk unit by a local disk system 104. When a r-write data receive process 110 checks whether the segment116 is allocated to the specified blocks by referring to a segment control block 118. If a segment 116 is not allocated, it allocates a segment 116. Then a r-write data receive process 110 stores write data to the area corresponding to the specified blocks. After that, a r-write data receive process 110 turn on the bits in block bit map 502, write block bit map to remote disk 503 and write block bit map to local disk 504 corresponding the specified blocks. Finally a r-write data receive process 110 notifies the completion of the processing to a local disk system 104.

A mainframe read/write process 108 in a remote disk system 105 can read/write the blocks received from a local disk system 104 through a CKD/FBA conversion function 115 because a CKD/FBA conversion function 118 is common to a local disk system 104 and a remote disk system 105. The processing of a mainframe read/write process 108 in a remote disk system 105 is basically same as the one in a local disk system 104. So the explanation is abbreviated.

A disk unit read write process 111 executes a data transfer processing between cache memory 113 and a disk unit 112. In this invention there is especially no originality in a data transfer processing between cache memory 111 and a disk unit 112. So the explanation of a disk unit read write process 111 is abbreviated.

Fig,6 shows the shows the total configuration the second embodiment. The difference from the first embodiment is that the management of cache memory is based on a CKD interface. In this case, one segment 116 is allocated to one track.
Fig.7 shows the structure of the segment control block 118 in the second embodiment. A disk unit address 500 is same as the one in the first embodiment. Track allocated to this segment 600 shows the address of the track which is allocated to the corresponding segment 116. Each bit of record bit map 502, write record bit map to remote disk 503 and write record bit map to local disk 504 is corresponding to a record. So, the number of bits of record bit map 502, write record bit map to remote disk 503 and write record bit map to local disk 504 is equal to the maximum number of the records which can be stored into one track. When each bit of record bit map 502 is on, it shows that the corresponding record exits in cache memory 113. When each bit of write record bit map to remote disk 502 is on, it shows that the corresponding record needs to be sent to a remote disk system 105. When each bit of write record bit map to local disk 502 is on , it shows that the corresponding record needs to be written to a disk unit 112 in a local disk system 104. In this case, HA200 is considered one record.

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As the management of cache memory 113 is based on a CKD interface 119 in the second embodiment, a mainframe read/write process 108 does not have a CKD/FBA conversion function 115 and a l-write data send process 109 and a r-write data receive process 110 have a CKD/FBA conversion function 115. So, when a l-write data send process send write data to a remote disk system 105, a l-write data send process executes a CKD/FBA conversion function 115. And when a r-write data receive process 110 receives write data from a local disk system 104, a r-write data receive process executes a CKD/FBA conversion function and then stores the converted write data to cache memory 113 .

This invention is also useful in the case where the management of cache memory 113 in a local disk system 104 is based on a fixed block interface 120 and the management of cache memory 113 in a remote disk system 105 is based on a CKD interface 119, as shown Fig. 8. Moreover, This invention is also useful in the case where the management of cache memory 113 in a local disk system 104 is based on a fCKD interface 119 and the management of cache memory 113 in a remote disk system 105 is based on a fixed block interface 120, as shown Fig. 9.

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IV. USE OF THE INVENTION

By using this invention, in a mainframe remote copy system, it is enabled to make p a data transfer infrastructure between a local disk system and a remote disk system much more efficient.

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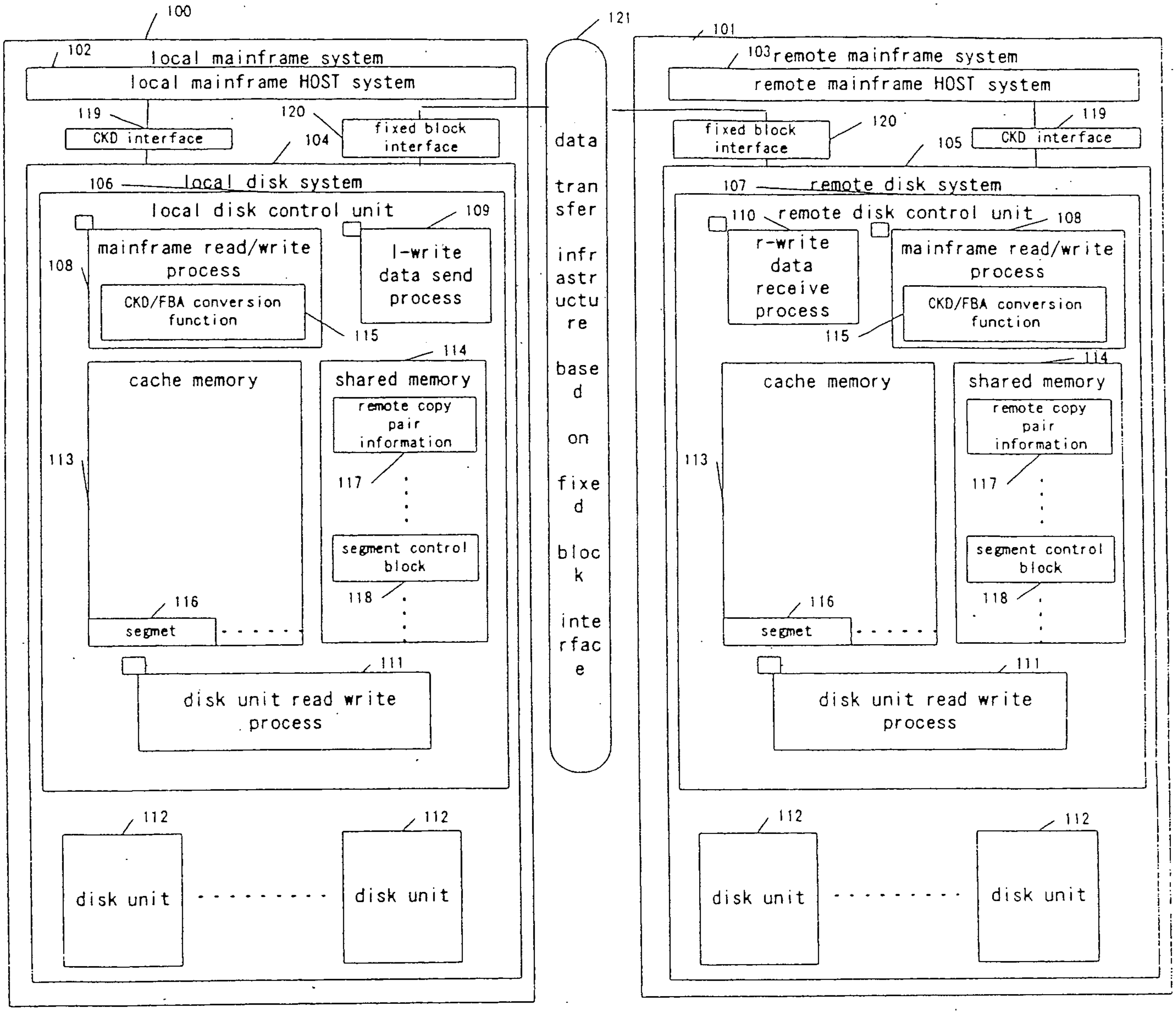

Fig. 1

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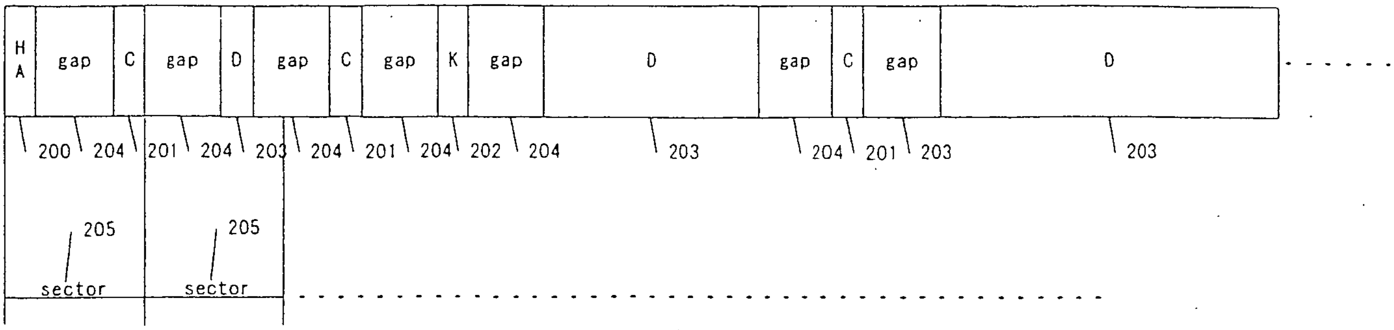

Fig. 2

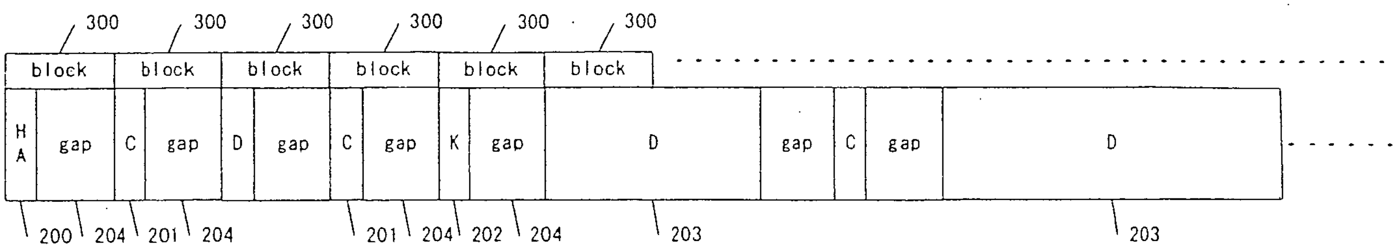

Fig. 3

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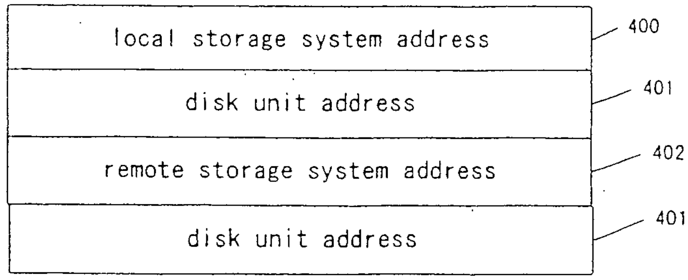

Fig. 4

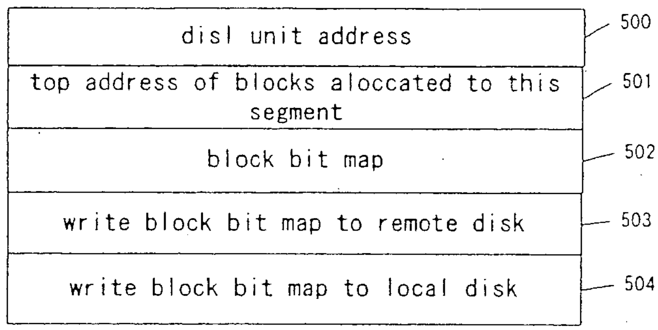

Fig. 5

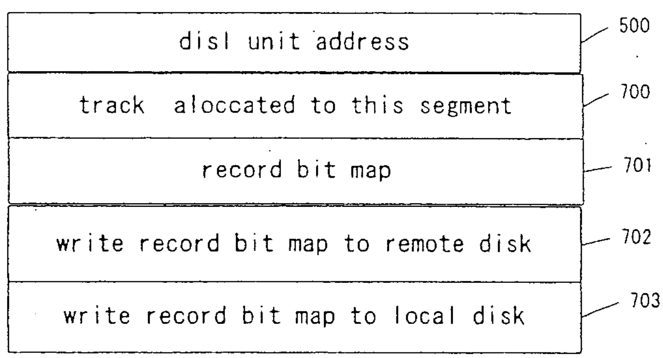

Fig. 7

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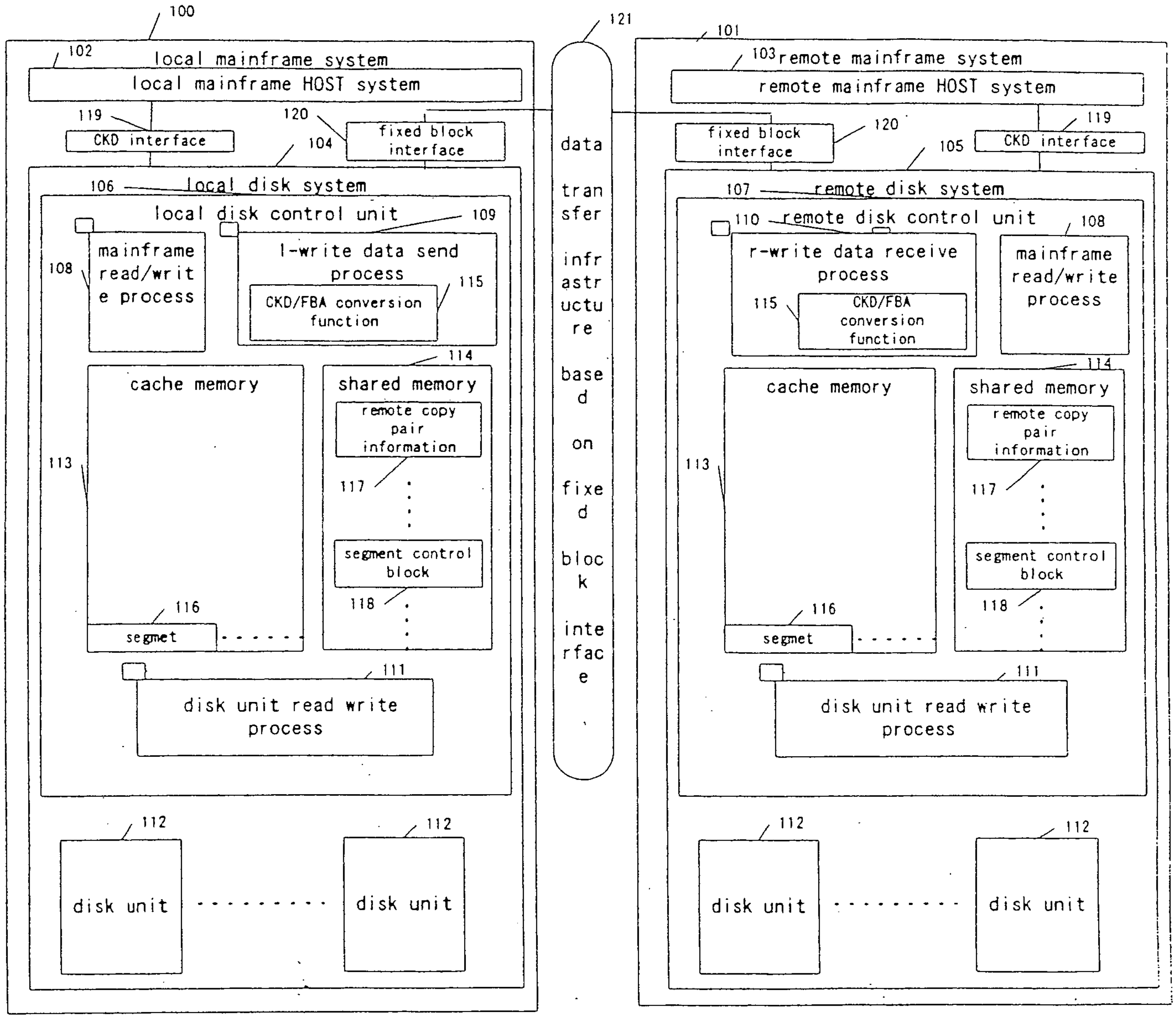

Fig. 6

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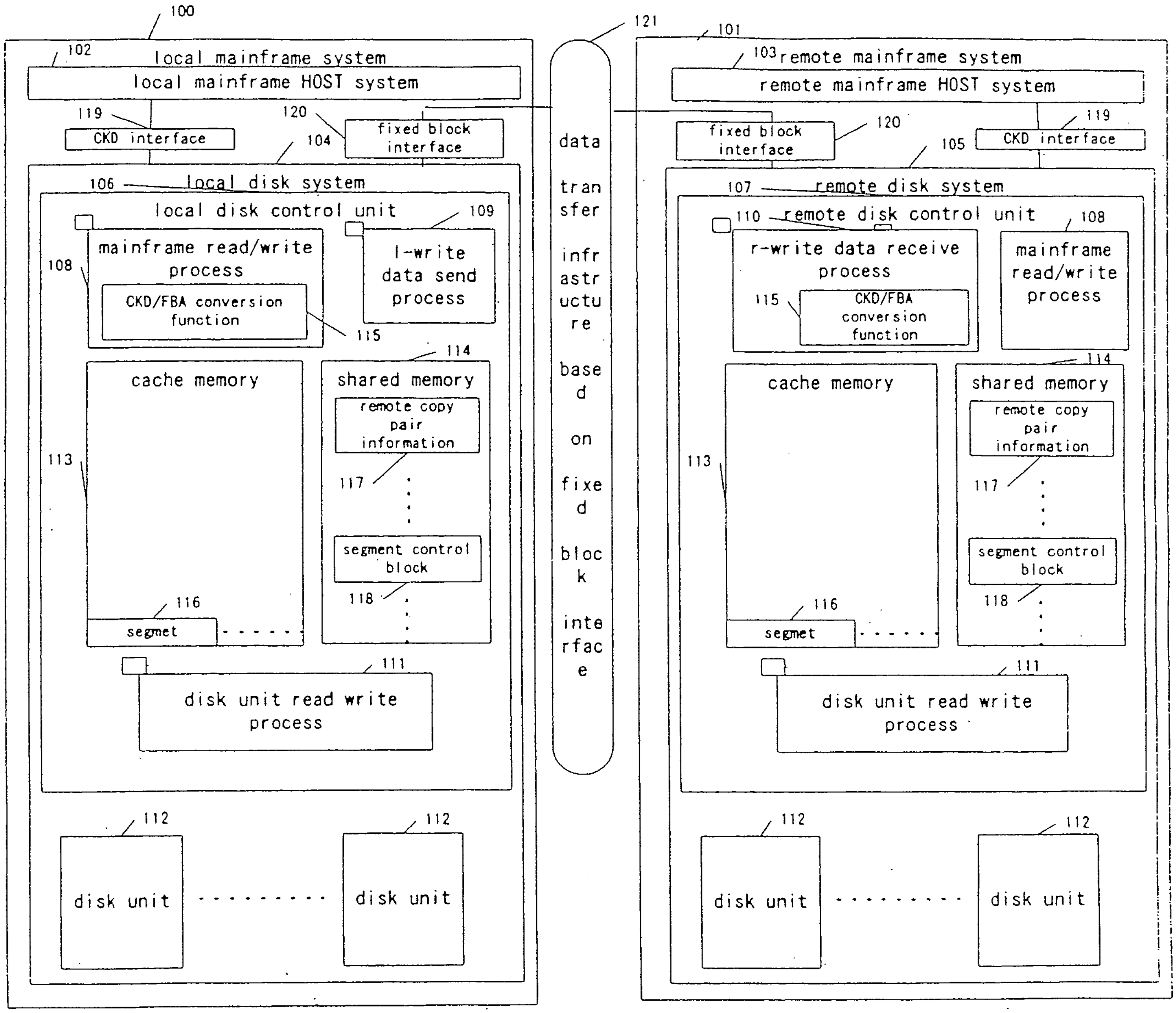

Fig. 8

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Signature of the Witness	Date	Signature of the Witness	Date
Naoko Iwami	[redacted]	*Kenji Yamagami*	[redacted]

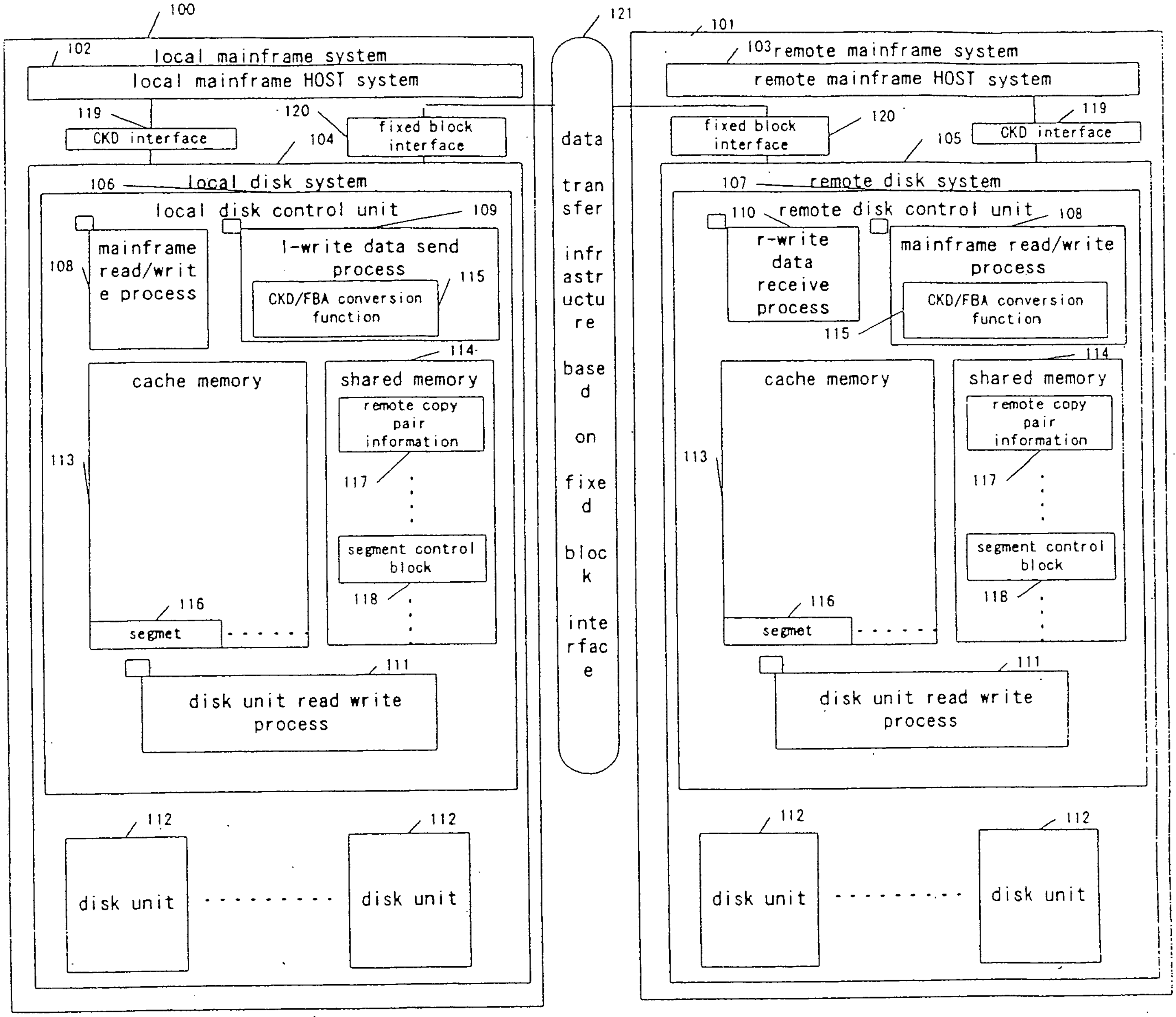

Fig. 9

Signature of the Inventor	Date	Signature of the Inventor	Date
Akira Yamamoto	[redacted]		
Signature of the Inventor	Date	Signature of the Inventor	Date
Signature of the Inventor	Date	Signature of the Inventor	Date
Signature of the Witness	Date	Signature of the Witness	Date
Naoko Iwami	[redacted]	Kenji Yamagami	[redacted]